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ABSTRACT

Evidence indicates that instructional technology, appropriately applied, can facilitate a more individualized, flexible, and adaptable educational program of medical instruction. It is recommended that support be provided for programs that will systematically educate medical instructors in the applications of instructional technology; that high funding priority be given to innovative applications of instructional technology; that the government support research to design and test new ways of using technology, and encourage industrial innovations. (SP)

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INSTRUCTIONAL TECHNOLOGY IN MEDICAL EDUCATION

By Hilliard Jason*

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OFFICE OF EDUCATION

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INTRODUCTION

The profession of medicine depends heavily on technology. Both practice and research have used and prompted new applications of technology for many years. Yet, instruction in medicine has not had a comparable orientation. Serious study and improvement of the instructional process in medicine has only recently begun. This attention is now leading to the implementation of approaches borrowed from other fields, as well as to explorations of new approaches specifically adapted to the particular needs of this profession.

These new developments, and the directions in which they will likely go, will be reviewed against the background of the recent history of medical education and its current major trends. This will involve an analysis of the central tasks of medical instruction and of the ways in which technology has made or can make its most important contributions.

Throughout this presentation the orientation will be exclusively toward technology as a factor in direct instruction, rather than a component of such administrative support functions as student record keeping, library management or budget handling.

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Accomodation to the assigned space limitations required the setting of priorities, which have led to the selective exclusion of many issues. The highest priority and, therefore, most attention, has been given to those aspects of medical education which seem most in need of strengthening and to those forms of technology which are believed to hold the most promise as responses to these needs. It is emphasized that these priorities, emphases, and omissions are reflections of my own views and predispositions. While a wide variety of personal experiences as well as systematic studies of my own and others have contributed to this paper, the categories selected for attention, the conclusions drawn and the recommendations offered must be interpreted as a distillation of informed judgments and substantiated findings, not as exclusively the latter.

The National Medical Audiovisual Center has compiled a bibliography of relevant references in this field, prior to October, 1966. We have developed a supplemental bibliography, bringing that one up to date. Both are attached as Appendices 2 and 3.

BACKGROUND AND PERSPECTIVE

The Tasks of Medical Education

The applications of technology in medical education must be considered against the perspective of the instructional purposes which are to be achieved. Undergraduate medical education is charged with the rather staggering task of negotiating a virtual transformation in the young men and women who are selected to become physicians. In some ways, this educational process is unlike any other. In addition to the huge and growing body of information and the large array of intellectual, manual and sensory skills which the students are to be helped to acquire, medical school faculties are increasingly seeing themselves responsible for helping students undergo some measure of personality modification. They are to enhance or develop the students' capacities for: establishing and sustaining high standards; making judgments and taking action in the face of considerable uncertainty; dedicating themselves to the notion that the welfare of others takes precedence over their own comfort and convenience; remaining productively engaged with experiences that tax the instincts and offend the senses; being supportive and empathetic while objective and clear-headed; putting aside a lifetime of becoming socially proper and discreet in relations with others, in favor of such activities as directly and comfortably asking virtual strangers for the most highly personal information; to mention only some of the highlights of this incredible educational challenge.

These and other goals must be fulfilled to an extent sufficient to grant each candidate privileges which are accorded

no other group in society. In their professional roles they will no longer be bound by usual considerations of emotional or physical privacy, they will be entrusted with the judgments and tools of life and death, and they will be put in the position of having to give advice which can cause others to significantly modify their total life style.

The Characteristics of Medical Education

The pattern of the past century has been for almost exclusive attention to be given to the sub-task of helping students acquire the largest possible body of information, to the relative exclusion of attention to the many other sub-tasks noted above. These other sub-tasks are now coming to be increasingly recognized as in need of systematic instruction for optimal development.

Until relatively recently medical education in this country was a rather standardized process. With very little exception from school to school, the first two years consisted of lectures and laboratory exercises in the basic sciences of anatomy, biochemistry, microbiology, pathology, pharmacology and physiology. The next two years consisted of "clinical clerkships" in which the students rotated through full-time experiences on the clinical patient-care services of internal medicine, obstetrics-gynecology, pediatrics, psychiatry, and surgery with a possible special out-patient experience in addition. The most outstanding feature of this curriculum was its "lock-step" quality. The implicit assumptions of such a rigid system were that all medical students must learn in the same way, at the same rate, and that all M.D.'s must have an identical basic preparation.

The inflexibility of this system, coupled with its primary preoccupation with the acquisition of information led, predictably, to the employment of a narrow range of instructional methods and a limited use of instructional technology. The nearly exclusive application of technology in this traditional setting was: occasional slides to illustrate formal lectures, occasional 16mm sound movies shown to large audiences, microscopes and other laboratory equipment used according to proscribed, "cook-book" type assignments, and, using the broadest definition of aids to instruction, indigent patients, who served as subjects on which students could practice skills.

Current Medical Education

The above description is a necessary background for understanding the circumstances from which many medical schools are now emerging. While the characteristics described above remain more or less current at a significant number of schools, the majority of medical schools in the country are currently engaged in a serious re-examination and modification of their instructional program.

Within the past ten years an accelerating series of events has led to a significant alteration in the basic structure and orientation of the educational process in medicine. There are increasing efforts to introduce flexibility into the curriculum, through reducing the number and length of required experiences, adding elective options and free time, developing tutorial and advisory systems, and

fashioning multiple-track rather than single-track pathways through the curriculum. Twelve medical schools have created offices of Research in Medical Education, in formal recognition of their efforts to study and improve their instructional programs, and nearly twenty other schools are now trying to identify suitably qualified individuals to develop similar units. In the largest national growth spurt ever, seventeen new medical schools are in the process of being developed as additions to the previously existing 86. Most of these new schools are capitalizing on the flexibility of their newness to test innovative instructional ideas. This country-wide spirit of change has brought many efforts at modification of instructional methods and introduction of new applications of technology.*

In this atmosphere of change, the growing variety of available technological aids to instruction is being adopted, even grasped at, with an eagerness that is both promising and worrisome. Of greatest concern is the propensity of many teachers to regard new devices as equivalent to new ideas. The act of accomodating old instructional notions to new packages, such as putting an old lecture on television or on a computer, can prove to be worse than no change at all. The glossy new packaging tends to deceive both the student and the teacher into believing that something new, and assumedly better, is happening. In actual fact, what has often happened is that considerable energy and money have been invested in creating a situation that is now even harder to change than was the conventional instruction it is mimicking.

*The most recent data on changes in the use of technology in medicine were assembled as part of a survey on curricular innovations, conducted by a Steering Committee of the Association of American Medical Colleges, of which I was a member. These data are presented as Appendix 1.

There have already been repeated examples in medicine of live lectures, poorly delivered and stultifying in person, which became even more evidently so on the TV monitor. One can now find a small but growing number of computer-based instructional units which are, in actuality, electronic reincarnations of the pompous, arrogant professor whose instructional strategy is the demand of compliance from the student rather than the promotion of independent skills. Simply put: bad instruction isn't made good by inclusion in a new medium.

The basic issue is that the automatic response of many medical educators has been the accomodation of conventional instruction to available technology. The pressing need is for continuous study and modification of the instructional process itself, with adaptation of technology to the needs of that instruction.

THE USES OF INSTRUCTIONAL TECHNOLOGY

The conventional uses of technology have tended to reinforce the conventional approach to medical instruction: that is, the primary preoccupation has been with the transmission of information. One of the major changes now taking place in medical education is the growing awareness that in the domain of information-learning, acquisition is merely the first of three necessary steps. Simple acquisition of information at some point in time is of no value if the conditions have not been arranged for effective retention of that information and for its availability for transfer to a variety of different settings. A companion recognition is that retention and transfer are optimized by having the original acquisition occur in a setting that is maximally like the setting in which this knowledge will later be applied. For medicine, the implication is that much learning must occur in the context of clinical problems which require solution.

Other major changes taking place in medical education are the increased attention being given to the areas of highly complex intellectual skills, such as problem solving, and to the non-cognitive areas of learning, such as inter-personal relationship skills. Among the major requirements for effective learning in these areas are the provision of models of what it is the student is to become and opportunities actually to engage in the application of increasingly refined approximations of these models, in maximally real settings.

The foundation premises of the review that follows are framed in terms of the primary requirements of medical education.

These are: 1) to identify the requisite knowledge, skills and attitudes of medicine, 2) to devise techniques and settings for the practice of these competencies, and 3) to provide frequent and reliable feedback to students on their success in acquiring these competencies.

The current major uses of technology can be seen as falling into four categories which derive from these requirements. They are the processes of: 1) transmitting information, 2) serving as role models, 3) assisting with the practice of specific skills, and 4) contributing to the provision of feedback. These four categories will be reviewed in terms of actual current applications, the directions in which these uses appear to be moving, and their potential for the decade ahead.

Purveying Information

The primary preoccupation of most instructors in most medical schools remains the transmission of information. The two primary vehicles for this transmission are still the spoken word and assigned readings in textbooks and journals. There has been a slow and steady increase in the use of projection slides, overhead transparencies, movies and, more recently, television for information transfer to large groups. An important but frequently unrecognized instructional aid for information transfer has become the ubiquitous duplicating machine. The distrubution of lecture notes, diagrams, summaries and selected items from the published literature is becoming a more common practice. Nonetheless, the non-illustrated, non-supplemented lecture remains a very common instrument in American undergraduate medical education. The chalkboard is still its most

common accompaniment, even in lecture halls where it is impossible for chalkboard writing to be seen by a large proportion of the audience.

Serving to offset the increasing use of aids in large group settings is the trend toward reduction of the proportion of instruction oriented toward large groups. The diminishing "core" of required learning in medical school and the growing recognition of individual differences in backgrounds and career plans have reduced the need for aids to knowledge transfer in large groups. While the balance is still some distance from being tilted toward the side of individualized instruction in medicine, there has been a growing interest in programmed texts, cartridge-contained self-view movies, projection slide-audiotape combinations, and more complex multi-media carrel arrangements. As in most other branches of education, the major problems delaying the growth of these approaches have been: lack of preparation of the teachers for the change in attitudes and skills required for new deployments of their own energies, as required for this different concept of instruction; the lack of administrative and financial support for the effort necessary to produce the materials to be used on an individualized basis; the absence of a systematic source of funding for the hardware necessary for these approaches; the failure of industry to take proper initiative in producing and distributing appropriate instructional materials; and the absence of any central agency or other systematic arrangement for sharing and distributing non-commercial materials among institutions.

Serving as Models

A very limited but potentially important use of technology has been the provision, on movie film or videotape, of expert examples of particular behaviors from which students might model their own behavior. This approach has been most frequently employed for presentations of skilled clinicians performing parts or all of a model physical examination of a patient. Less commonly, this approach has been used as part of the teaching of medical history taking. The most elegant application of this approach to date was directed by Dr. Allen J. Enelow (now of Michigan State University) while he was at the University of Southern California. He and his colleagues developed a series of ten videotapes which were programmed to give the viewer an opportunity to select among three options of possible physician behavior at multiple branching points in the course of the conduct of interviews of patients who presented particular paradigmatic problems. This imaginative technique appears to have maximized student engagement and growth and is coming into increasing use around the country.

All of these approaches to providing models for students are fundamentally different from the much shorter presentations of particular skills which are meant to be repeatedly viewed while the skill is actually being practiced by the student. In these cases, the presentations are providing "supervisory," more than "model," functions. They will be discussed below.

Facilitating the Practice of Skills

Two separate but related new approaches to the use of

instructional technology hold great promise for improving the learning of complex skills in medicine. The first consists of short projection slide-audio tape, movie film or videotape sequences designed to serve as both models and reference checkpoints for individual students who are practicing particular technical skills. The instructional materials include the equipment, devices or synthetic models which the student practices manipulating, while referring to the visual demonstration, which serves as a "supervisor." A fair range of such units now exist, including instruction in such diverse skills as withdrawing blood from a vein, doing a spinal tap, scrubbing for surgery and plating out a bacterial culture.

The second application of technology in this category involves simulation, in which the technological device itself becomes the equipment with which the student interacts in the process of practicing the skills he is learning. There are three major categories of skills in medicine: manual, sensory and intellectual. Simulation techniques have begun to be developed for instruction in all three areas. They will each be reviewed.

One of the older instructional aids in medicine is the mannequin created to represent the female birth canal. Together with a doll the size of a newborn it provides the student with his first practice of the maneuvers necessary in delivering a child. At the other end of the continuum from this simple and straightforward simulation is the highly sophisticated application of modern technology known as "SIM 1". This life size, life-like computer-controlled mannequin was developed under the direction of Drs. Stephen

Abrahamson and J. D. Denson at the University of Southern California, with the collaboration of Aerojet General. It permits the practice and effective learning of many of the complex skills involved in the administration of anesthetics. SIM 1 breathes, has a heartbeat, pulse and blood pressure, and the pupils of his eyes dilate and constrict. All of these functions and many others respond approriately to varying dosages of several different drugs, administered either by injection through a "vein" or by face mask through the "lungs." This is one of the most effective illustrations to date of the application of modern technology at a level of sophistication which matches in complexity some of the skills which must be learned in medicine. It seems clear that SIM 1 will be the forerunner of a large family of devices which will provide varying degrees of approximation of aspects of human functioning as a basis for the practice and mastery of the complex technical skills of medicine.

The most advanced approach to instruction in the area of sensory skills so far developed are the various "heart sound simulators", pioneered by Dr. Abe Ravin of Denver, Colorado. Using a variety of approaches, these simulators have in common the capacity to generate a virtually infinite variety of life-like heart sounds at controllable rates. Learning to distinguish a particular heart sound on a live patient may be nearly impossible, with that sound being buried amidst a variety of other natural sounds, while occuring at a rate of, say, 90 a minute. With the simulator, the particular sound can both be isolated for exclusive attention and can be slowed to the easily discernible rate of, say, 10 per minute. A gradual increase in the rate of repetition and the quantity of other sounds permits

the systematic learning of the discriminatory skills which are required. It seems indisputable that analogous devices to assist in the learning of other complex sensory skills, such as interpreting breath sounds or eye findings, are needed and deserve to be developed.

In addition to instruction in manual and sensory skills, the acquisition and refinement of intellectual skills is now receiving increased attention. Technological reinforcement of this task is now made possible with the advent of the remote access time-shared computer. Probably the most generally required, and possibly the most poorly developed, intellectual skill in medicine is that of systematic inquiry: subsuming the skills of problem sensing, problem formulation, systematic information search and the formulation of judgments and plans for action. The characteristics of the computer make it possible to repetitively present the student with instances of sequential complexity which require the application of these component skills. These intellectual skills are less well understood than are technical and sensory skills such as drug administration or heart sound differentiation. As a consequence, we do not yet have the prototype application of effective instruction in the area of intellectual skills. Work is being done, however, in several centers which should lead to such a development in the near future. Potentially, the most powerful approach will involve the computer as a major instructional resource.

This review of newly appearing computer based and technological simulations has been all too brief. In my view, the instructional needs in medicine are of such complexity that simulation is likely to become the most important new educational development of the decade.

To re-emphasize the sources of this great potential, several of its major advantages will be mentioned:

1) The setting in which the knowledge and skills which are being learned will be applied can be maximally approximated.

2) The number of stimuli with which the student is confronted can be manipulated. This permits an avoidance of the sometimes overwhelming impact of having to deal with all the dimensions of the full, real situation and enables a systematic acquisition of component skills, leading to their progressive amalgamation into a total set of skills.

3) The amount of "noise" in the system can be artificially reduced, permitting concentration upon the competencies being acquired. There can then be a gradual introduction of these distracting influences, up to the level actually found in reality.

4) The content of the material to which the student is being exposed can be made maximally relevant to his level of readiness and to his current preoccupations. These usually derive from the other instructional activities with which he is then engaged. (A patient with a particularly relevant disease does not have to be searched for, he can be created.)

5) The student can repeatedly practice a skill as often as is appropriate for effective learning. (One cannot subject real patients to repeated procedures.)

6) The student is freed of the distracting risk of making a sick patient even sicker or an uncomfortable person even more uncomfortable. He can concentrate on the specific skill being acquired and can separately deal with whatever anxieties he might have about patients, under more appropriate circumstances.

7) The stimuli to which the student is responding are under precise control and therefore "standardized", so that the student's response can be accurately evaluated for purposes of "diagnosis" of his further instructional needs.

All of the above considerations regarding simulation have

led to the recent development of an especially important innovation in instructional aids in medicine, although technology in its usual sense is not involved. This is the use of live people as simulators of specific medical conditions or of the general role of the patient. Doctor Howard Barrows of the University of Southern California pioneered this approach in training actresses to simulate the history and physical findings of particular neurological conditions, primarily to increase the reliability of student examinations. At Michigan State University, Drs. James B. Thomas, Norman Kagan and I have employed trained drama students and housewives as "patients" to help medical students begin to learn the skills and self-awareness necessary for the establishment of an effective and productive doctor-patient relationship. In combination with a feedback approach described below, this technique has led to rapid and lasting acquisition of some of the most complex competencies required in the field of medicine.

Providing Feedback

It can be safely asserted that learning occurs very inefficiently without effective feedback. In medicine, modern technology has very recently begun to make possible more sensitive and more complete readings on student behavior than had previously been provided. Potentially, it can carry this development forward dramatically.

The growing use of programmed texts, teaching machines and erasure or tab-test examinations has begun to contribute significantly to the quality and quantity of information students receive about their own learning progress. In addition to these increments in the

area of knowledge acquisition, technology is now making possible the provision of comprehensive feedback in the previously largely neglected areas of intellectual skills and professional behavior.

In addition to its function as a large teaching machine, providing moment to moment feedback during the process of information and concept acquisition, the computer brings the exciting promise of providing feedback on the development of complex intellectual processes. A student who is engaged with a computer in the solution of medical problems can receive more than just item-by-item responses to his individual actions. The computer's capacity to retain a total record of all transactions in which it has engaged enables the student to be provided with the cognitive equivalent of a videotape of his thought processes. In fact, the computer print-out of the problem-solving process in which the student has participated is far more flexible than a videotape. It is more like a map which can be scanned in its entirety and compared to other maps, for critical evaluation. Much like the golfer who makes startling progress through being confronted with a playback of a videotape of his own swing, the medical student who is learning intellectual skills, when provided with the feedback of a print-out, will certainly make unprecedented strides in areas that were previously barely touched by conventional medical education.

The memory and adaptability of the computer permits storing great ranges of evaluation materials and recording all its transactions with students, enabling the creation of an unusually comprehensive and elaborate evaluation system, both of student performance and

instructional effectiveness. The singularly attractive possibility which emerges is that of "computer-monitored" instruction. In a way that has not been possible before, student progress can be assessed from day to day, rather than term to term, and instructional adjustments can be made, literally, as needed. This process can be seen as analogous to the continuous inventory which industries now use. It can, of course, be developed independently of whether or not the instructional program uses the computer as a teaching device. The extent to which this monitoring process might elevate our efficiency can, at present, only be imagined.

Television is now beginning to be applied to the provision of quite a different form of feedback, which is likely to have substantial impact in the next few years. Among the most complex of the skills to be learned in medical school are those of relating effectively to patients. The combined skills necessary to establish a productive, professional relationship have only recently begun to be carefully defined and explicitly taught. One of the central features of the doctor-patient relationship course using simulated patients at Michigan State University is the videotaping of the medical students as they conduct this first series of interviews with patients. These interviews are witnessed, live, by instructors and other students and then immediately played back to the observing group and the interviewer. The playback can be stopped at any time for purposes of questioning and discussion. The feedback effect of being confronted with one's own behavior appears to be one of the most instructional factors of the many at work in this program.

CONCLUSIONS AND RECOMMENDATIONS

As James Reston has pointed out, the ancient Chinese exhibited great wisdom in formulating two separate characters to convey alternative interpretations of the concept of "crisis." For them, crisis could mean either "danger" or "opportunity". Medicine in general, and medical education in particular, have been described as currently facing a severe crisis, in several forms.

There is mounting pressure for significantly more doctors to be produced. At the same time there is a strong push to create a new kind of physician who is more responsive to current social needs than were his predecessors and who is a far more effective continuing self-educator, among many other things. In addition, all this is to be accomplished in less time than medical education now takes.

These forces for a dramatic change in the character, effectiveness and efficiency of medical curricula come at a time when we do have an increased understanding of the educational process and when the number of potentially available technological aids to instruction have mushroomed. If the conditions could be arranged for us to take suitable advantage of the new resources available, the current crisis, which has all the earmarks of a dangerous situation, could be converted to a welcome, indeed exciting, opportunity.

It is asserted that the evidence is now in hand to indicate that instructional technology, appropriately applied, holds the promise of facilitating a distinctly more individualized, flexible and adaptable educational program. These characteristics, in turn,

will significantly elevate the quality of medical instruction. The pressing need is for those changes which will encourage and enable the most appropriate exploitation of technology by the largest number of individuals. The key steps toward this goal are presented below. My major recommendations appear in italics.

More than anything, the effective use of technology requires careful planning. The instructor must have clearly defined his general goals, he must have ascertained the specific competencies his students are to acquire and the steps necessary to get them there, and he must have determined which instructional materials exist or need to be created for those purposes which can be best achieved with media. For understandable reasons, this type of advance planning is still rare in medical education. Medical faculty members bring with them an expertise in a medical discipline but no specific preparation for their role as instructors. The large majority tend to teach using the only model they know: the way they themselves were taught. Responding to the current ferment in medical education, as well as trying to exploit the potentials of technology, requires significant departures from that pattern. Medical faculty will need special help to learn how to plan instruction and use technology. *It is, therefore, strongly recommended that support be provided for programs that will systematically educate medical instructors in the applications of instructional technology.*

In addition to the educational program required to achieve a meaningful change in the teachers who are to deploy their own talents differently, there must be a change in the administrative format within

which these teachers work. The medical schools will have to alter their reward system to provide suitable recognition for contributions to instructional programs at the level of detailed planning, instructional materials development and the fashioning of innovative techniques. *This transformation can be facilitated by modifying the basic support grants to medical schools to give high priority to innovative applications of instructional technology.*

It seems clear that the most promising instructional technology is both the most expensive and the least well developed at this time. The potential applications of multi-media carrels, television and computers can be imagined but have not yet been realized. *The need at this time is for government support of research and development projects and feasibility studies which design and test new ways to use technology.* It does not seem as justified, at this time, for support to be given to the implementation of programs using expensive technology unless they incorporate systematic experimental attempts to evaluate the differential effects of alternative approaches.

Despite the lack of systematic support and minimal institutional encouragement, many individual faculty members have begun to generate new instructional materials which are being used in their local setting. A major economy move as well as source of support and professional prestige for the developers of instructional materials would be the opportunity for regular dissemination of quality materials among other institutions. *It is recommended that the National Library of Medicine, through the National Medical Audiovisual Center,*

be invited to explore the possibility of serving as a central clearinghouse to facilitate and promote the distribution of quality materials throughout the country.

An impediment to the effective application of instructional technology has been the failure of industry to respond to the educational needs of the consumer. The confusion created by the lack of standardization of equipment, especially in television; the efforts to foist onto unsuspecting educators equipment which was really designed for use in sales promotion and which is lacking in the flexibility needed for instruction; the relative absence of quality control of the programmed texts and other instructional materials being promoted; all indicate a need for some form of intervention. If we are to successfully profit from the potential contribution of American industry we must find ways to make it economically attractive for new avenues to be explored and for high standards to be maintained. To illustrate with a simple example: movie film will not have achieved its full instructional potential until it can be used like audio tape; that is, until it can have the flexibility in use which is made possible by fast forward and fast reverse controls in a simple cartridge mechanism. We would have had this breakthrough by now if suitable incentives had been available. *It is recommended that government support, guided by the best available educational thinking, be provided to encourage industrial innovations.*

This paper cannot be concluded without an examination of the frequently raised question: Can technology replace the live human teacher? B.F. Skinner could have been referring to all technology when he said, "Any teacher that can be replaced by a teaching machine . . .

deserves to be!" Technology has indeed been demonstrated to do better than live teachers many of those things that teachers now spend time doing. The challenge we face was anticipated more than 50 years ago by E. L. Thorndike when he wrote, "A human being should not be wasted in doing what 40 sheets of paper or two phonographs can do. Just because personal teaching is precious and can do what apparatus cannot, it should be saved for its peculiar work." We have only barely begun to identify what is, in fact, the "peculiar work" of the live teacher. It clearly involves much more at the level of instructional planning, individual guidance, personal supervision and direct observational evaluation of students, and much less at the level of information dispensing than has conventionally pertained. Technology holds the remarkable promise of relieving the teacher of the burden of doing a variety of routine tasks which he can now carry out more effectively through the proxy of careful planning. He could then turn his attention to far more subtle and complex issues, including many for which his own abilities would be significantly bolstered by the proper use of technology. These changes could elevate the quality of medical instruction and medical learning to levels we have heretofor hardly dared imagined. This is not a hollow dream. The necessary educational expertise and technology are at hand to permit implementation of the studies necessary to convert this dream into a reality. Let us hope that the necessary support can be found so that this conversion process can be accelerated..

APPENDIX I

AAMC CURRICULUM QUESTIONNAIRE*

Section V. TEACHING AIDS OR MATERIALS

Question Posed:

Information is requested in the following table about selected teaching aids or materials used in your NEW CURRICULUM as compared to their use in the BASE CURRICULUM. Using the scale below, please assess the intensity of use of the aids or materials (listed vertically).

Summary of Responses Received:

TEACHING AIDS OR MATERIALS	USE IN NEW CURRICULUM				USE IN BASE CURRICULUM			
	Extensive	Moderate	Minimal	No	Extensive	Moderate	Minimal	No
Models & Mannequins	6	35	7	7	1	30	34	9
Programmed Instruction	7	22	35	20	0	5	30	40
Bibliographic Reference & Supplements	29	51	5	0	16	44	13	1
Projection Slides	52	28	5	0	42	28	4	0
Movie Films	14	52	17	0	9	38	25	2
Single Concept Films or TV Tapes	10	38	25	10	1	11	37	25
Live TV	9	37	20	17	1	9	27	38
Taped TV	11	34	22	17	2	12	23	39
Audio Tapes	6	25	38	11	1	5	40	26
Computers	10	16	35	21	1	4	30	41
Role Playing	2	10	33	30	0	1	24	47
Mechanical Simulators	1	3	29	40	0	0	16	55

*Distributed to the 117 Canadian and U.S. Medical Schools.

Appendix 2

TOWARD IMPROVED LEARNING

A Bibliography of Significant Articles for the Medical Educator*
Prior to September 1966

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Appendix 3

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